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Editorial

Ten Years After

TEN years ago, on December 2, atomic energy was first made available to man. The anniversary of the first self-supporting nuclear chain reaction was celebrated, in a rather subdued spirit, by the veterans of the historic experiment of December 2, 1942. The gathering was held in the squash court of the University of Chicago, where the first atomic pile had stood. Many newspapers carried editorials marking the anniversary—none too jubilant. No wonder—the celebration of the tenth anniversary of atomic energy had been ushered in, a month earlier, by a "shot heard around the world"! (With radiation counters, this is no longer a poetic exaggeration.) The first hydrogen bomb, or a reasonable prototype of such a bomb, went off at Eniwetok.

Within ten years, the military terror of atomic weapons—which appeared the ultimate imaginable at the time of Hiroshima—has been multiplied tenfold or more while the beneficial applications of atomic energy have fallen far short of popular expectation. Even the abundant supply of radioisotopes, which has been the main boon of atomic energy to science and industry, has yet to claim credit for a single really great discovery in biology, physics, or chemistry, or a single revolutionary cure in medicine. Feats of atomic engineering, such as destroying hurricanes, or leveling mountains with atomic explosives (the latter once rashly claimed by Vishinsky for the Soviet Union), have remained science fiction. Atomic power plants are still in the developmental stage, and when the first of them are ready—which may be a matter of two or three years—they will be either devoted entirely to military use (as in the case of the atomic submarine), or will owe their existence to military by-products (as in the presently planned nuclear power stations, which are to pay for the costs of their upkeep by the sale of plutonium to the government).

Ten years after the first chain reaction got under way in a makeshift laboratory, the country is dotted with new wonderful research laboratories. Their enormous buildings, equipped with all the modern facilities, where hundreds of well-paid PhD's are flanked by assistants and technicians, draftsmen and machinists, their giant atom-smashing machinery, make the scientist who grew up in the austerity of pre-bomb laboratories, blink and rub his eyes in a mixture of admiration, envy, and misgivings. Most of the work done in these laboratories is good scientific work, inspired by the same urge to delve into the secrets of natural phenomena that has moved science throughout its history. But these laboratories exist not because the American people and the American government have learned to appreciate the material promise and spiritual value of broad, disinterested scientific research, but because a scared nation and a frightened Congress look to them for the production of ever better and ever bigger atomic weapons. One asks oneself: Would these great national research centers survive the shock of a sudden peace, or would they become ghost towns?

As piles of atomic bombs grow higher and more threatening, the quest for unattainable military security increasingly dominates political life everywhere. The dictatorships turn ever tighter the screws of oppression, destroying even the scant remnants of the freedom of movement and exchange of ideas that existed before 1945. Democratic states sacrifice many long-cherished freedoms: They introduce passport and visa restrictions and inquiries into opinions and associations of government and private employees. Police files accumulate on practically every citizen. Security zealots call for more and more purges and for conformism instead of dissent, which is the spice of democracy. This reversion to a past which free nations seemed to have left behind long ago, is, to a very large extent, the consequence of the fateful discovery of atomic energy.

It is a sad and terrifying picture. There is little satisfaction in the knowledge that this development was anticipated in 1944 by those who had tried, then, to weigh soberly the probable effects on human affairs of the release of atomic energy. In recording the early political discussions between scientists on the Manhattan Project, in re-reading the memoranda directed by them in 1944 and 1945 to President Roosevelt and to Secretary Stimson, one is painfully aware of how useless the foreknowledge of disaster has been.

The shock of the destruction of Hiroshima and Nagasaki, the disclosures of the Smyth Report, the frantic education of world public opinion by atomic scientists, have not been able to change decisively the behavior of states and nations. Again, as in the past, victors in a coalition war face each other as rivals for world supremacy. Once more a ruthless aggressive power, motivated by a Messianic ideology, despising and distrusting the rest of the world, risks its own destruction in the pursuit of a supposedly rational power policy. The terrific destructive power of nuclear explosives, while restraining the outbreak of open war, does not enhance the readiness to seek reasonable solutions to conflicts of power and ideology, but instead, exacerbates them and increases the pressures of fear, hate, and suspicion.

* * *

When the *Bulletin of the Atomic Scientists* was started in December 1945, there still was hope that the shock of the first atomic explosions, and the threat of their repetition on an enormously enlarged scale, could induce all political systems to adopt a policy of rational cooperation. Was not the threat of atomic destruction clear and obvious enough to make even the most hidebound or passion-blinded politician forget his pet hates and preconceived beliefs? The international control of atomic energy, and its development in the interest of all mankind, appeared then as a possible wedge to open the door into a new era. The chances for success were never high, but they were real; and the scientists were those who were most ardently hopeful.

Scientists are not entirely rational, not even in their own work; but, among all professional groups, they are the ones most consistently forced to use rational thinking as the main guide of their activity. Their professional success depends on keeping all other influences under check. When scientists enter the public sphere, many of them become as emotional as the next man and equally susceptible to hatred or prejudice. Yet, on the average, scientists as a professional group are likely to bring into public affairs a little *more* rationality than is common to people whose very success in life more often than not depends on following irrational urges and exploiting irrational tendencies in human nature. The belief in the power of reason to influence the behavior of nations made scientists hopeful of a successful solution to the problem of atomic energy control.

The hope has failed. Ten years after Hiroshima the world presents a picture, not of progress toward cooperation, but of tremendous strife, fanned by the primitive lust for power, and by mass passions of nationalism, class and race hatred, envy, and suspicion.

★ ★ ★

As this situation developed, many scientists lost their belief in the usefulness of continuously educating the world to the realities of the atomic age. Some among the friends of the *Bulletin* have counseled it to quit, and to leave mankind to its folly. Others —the majority—have urged it to go on. Where sudden shock treatment has failed, slow education might yet bring unspectacular, but important success. The fear of atomic destruction, while it gives no hope for permanent avoidance of an all-out war, at least raises what chemists might call "the activation energy" needed to begin a war, and permits an unstable state of world tension to exist much longer than would have seemed possible in the past. We may thus have more time for reflection, and for the slow building-up of a rational society, than many people are inclined to believe.

A closer look at the developments of the last ten years shows that the lessons of the atomic bomb have not been entirely lost on mankind. A trend toward unification, toward leaving behind age-old national hatred and rivalries, is apparent among the nations of the West. In America, the first wave

(*Continued on page 314*)

The Monte Bello Explosion

SIR WILLIAM PENNEY

This account of the British bomb test was broadcast on November 7. Sir William Penney, who was knighted for his contribution to the successful development of the British atomic weapon, was scientific director of the project.

I EXPECT that most of you read Mr. Churchill's statement to Parliament about the Monte Bello test. There is little that I can add, but even so you may be interested in getting a personal account from a scientist who took part in the trial.

When the planning began, a lot of thought was given to deciding which type of explosion would provide information and experience of the greatest value. Purely scientific measurements are most easily made when the weapon is placed at the top of a high tower, but there were other weighty considerations. The Civil Defense authorities in this country badly needed more data about atomic explosions and accordingly the test was planned to get as much novel information as possible for Civil Defense. The decision was made to explode the weapon in a ship moored near land, thus simulating an explosion in a port. The ship was to be equipped as a scientific transmitting station, sending out by radio a vast number of measurements about the nuclear explosion before the equipment was destroyed. More scientific apparatus was to be placed on the islands to record other phenomena such as blast, heat, and radioactivity.

The question of where to do the trial presented quite a problem. Suitable sites for this sort of work are not easy to find. The Admiralty made a search through their charts and it seemed as if the Monte Bello Islands would offer everything that we wanted. The Australian government readily agreed to a survey being made of these islands and it was found that they were entirely suitable. The Australian government, at this stage, generously gave us permission to hold the trial there. They also offered us substantial assistance in preparing the site and in supplying us with food, water, and everything else which we needed, in order to work and live in security at Monte Bello.

At a very early stage it was decided to conduct the trial as a military operation and, in May of last year, Admiral Torlesse was appointed to work with me and prepare a detailed plan on the good principle that "he who plans an expedition should also carry it out."

An elaborate trial, like the one at Monte Bello, is not completed without some anxious moments. Fortunately there were not many of them, but the night before D-1 Day was, perhaps, our worst spell. In order to get the right winds at the time of the explosion we had to choose a period of strong winds for both D-1 Day and for D-Day. We got the strong winds all right! The winds were so strong that we were not sure that the boats could get the scientists all round the island to make the final adjustments of their instruments. However, as always, the Navy and the Marines rose to the occasion and the work was completed with nothing worse than a lot of wet shirts. Even up to an hour before the explosion, we were still anxiously watching the winds to see if the forecasts of the weather-boys were going to prove accurate. In fact, their predictions were absolutely right and, with much relief, the firing clock was started.

I was on the flight deck of Campania with Admiral Torlesse and most of the ship's company. We all faced away from the explosion as the last few seconds were counted over the loudspeakers. Suddenly there was an intense flash, visible all round the horizon. We turned round to look. The sight before our eyes was terrifying—a great, grayish black cloud being hurled thousands of feet into the air and increasing in size with astonishing rapidity. A great sandstorm suddenly sprang up over the islands. It seemed ages be-

fore we heard the bang but, in fact, it was only a minute.[1] Somewhat to our surprise, a second bang—at least as loud as the first—followed a few seconds later. At the same time we felt a peculiar sensation in our ears such as one has in an aircraft losing height rapidly. We were feeling the suction, or reduced pressure, which always follows a blast wave. All the time the cloud was getting higher and higher and assuming fantastic shapes as it was pulled about by the strong winds at different altitudes.

The explanation of the two bangs heard on the ships and also heard on the Mainland is actually quite simple. The first bang was the direct sound wave, and the second was a reflection from a layer of warm air some two miles up.

Many comments have been made about the shape of the cloud and how different it was from the mushroom cloud with the very high stalk shown in most American pictures of atomic explosions. The great weight of the mud and water in the cloud at Monte Bello kept the cloud from rising very far. Even so, the top of the cloud at Monte Bello rose just over two miles above the sea. The explosion had some resemblance to that of the atomic weapon exploded by the United States in the waters of the Bikini Lagoon. The cloud there rose to a height of a little over one mile.

The peculiar Z-shape of the cloud ten minutes or so after the explosion was due to the strong winds blowing in quite different directions at different heights. The cloud was pulled into a gigantic spiral shape which, when seen from the ships and from the Mainland, appeared rather like a letter "Z," rapidly moving northwards away from the islands and from the Mainland.

The experiment went according to plan and the scientific records were complete. We know what happened and we can give to the Civil Defense authorities some accurate answers to some of their problems.

It is, of course, an easy matter to report that we obtained a complete set of records: it is more difficult to convey the scale of the effort involved. Electronic gadgets were the basis of nearly all measurements. We took no less than three hundred different types of electronic devices, and many of them were used in half-dozens or dozens. Some of them looked like television sets, but instead of a viewer watching a picture on a screen, a camera was used to photograph the record which appeared. In other cases, measurements were automatically passed by radio to a central recording office in one of the ships.

Lots of photographs of the explosion were taken—both stills and moving. Most of the cameras were of types that can be bought in the shops or from scientific instrument makers. However, we were very keen on getting ultra-rapid photographs of the very early stages, when the fire-ball began to burst through the ship. No camera can be bought with the speed that we wanted and so we designed and built our own. We ran our camera in such a way that it took about a hundred pictures at intervals of ten micro-seconds—that's to say, at the rate of 100,000 pictures per second. The exposure time for each picture was one ten-millionth of a second!

We expected that the contamination on the land near the explosion would be severe, and one of our primary jobs was to measure the degree of contamination. Naturally, we were not going to take risks by entering the area too soon. The re-entry survey parties all wore protective clothing covering them from head to foot and they also wore gas masks. The appearance of men in this clothing, scrambling about on the white sand-hills in the blazing sun and peering at their instruments every few seconds, was a weird sight. Everyone in the parties sweated profusely and one man lost no less than 17 lb. in a single trip. However, on return to the health control center, a few long drinks of water, some salt tablets and a meal with lots of tea, quickly restored the loss of weight and nobody felt any the worse.

An aspect of the trial which calls for comment is the harmonious way in which scientists and servicemen have worked together in a combined amphibious operation. The Fighting Services nowadays often comment on how technical all their paraphernalia is becoming. On this occasion they not only had to put up with loads of scientific apparatus but they also had the scientists as well. The ordeal was not as bad as they feared and everybody learned valuable lessons.

So much for the trial. Now for the weapon itself, about which, of course, I can say little. You no doubt realize, if only from the cost of all large atomic energy projects, that the weapon is a complex affair involving specialists in many fields of science and engineering. The fissile material and all the equipment used at Monte Bello were made in Britain. I want, therefore, to take this opportunity of paying my tribute to all those in the Ministry of Supply establishments and ordnance factories, and in industry, who worked so hard and so loyally to get the work done. I, myself, would especially like to add a word of thanks to my own staff.

Finally, Mr. Churchill has said that the results of our atomic weapon program should be beneficial to public safety. As a scientist, I should like most strongly to agree with this view. The energy and enthusiasm which have gone into the making of this new weapon stemmed essentially from the sober hope that it would bring us nearer the day when world war is universally seen to be unthinkable.

[1] This indicates that the ship was about 20 kilometers away from the explosion.—Eds.

The "Hydrogen Bomb" Story

ALL the information ever officially released on the subject of "thermonuclear weapons" (superbombs, fusion bombs, or hydrogen bombs), consists of three brief sentences:

"I have directed the Atomic Energy Commission to continue to work on all forms of atomic weapons, including the so-called super-bomb." (President Harry Truman, January 31, 1950)

The Eniwetok weapon tests, carried out between May 1 and May 11, 1951, "included experiments contributing to thermonuclear weapons research." (Joint release by the Defense Department and the Atomic Energy Commission, May 25, 1951)

"The test program included experiments contributing to thermonuclear weapons research." (Atomic Energy Commission release of November 11, 1952)

Note that the language of the 1952 release is literally the same as was used in May 1951.

This is all the American people and the nations of the world are supposed to know about a development which may be decisive for their future—perhaps will determine their very survival.

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As a matter of fact, the American people—not to speak of the Soviet government—know much more about thermonuclear weapons and the progress of the American hydrogen bomb project than they are officially supposed to know.

This knowledge has been derived from two sources: One is the ineradicable habit of American politicians, generals, and simple citizens to talk out of turn, a habit encouraged and exploited by the uninhibited and irrepressible tribe of American reporters. (It can be claimed that the much abused scientists—barring, of course, Soviet agents such as Fuchs—have proved the most reliable keepers of secret information.)

The other source of public information about thermonuclear weapons is the textbooks and research papers on fundamental physics. These permit scientists—everywhere in the world, and without access to any "classified"

data—to distinguish the possible from the impossible, and the likely from the unlikely. Public documents, such as budget estimates, congressional hearings, AEC reports, etc., help an informed, analytical observer to cross-check the various unofficial disclosures, leaks, and rumors that find their way into the press, and to emerge at the end, with fairly reliable general conclusions. Through the medium of the more conscientious and knowledgeable newspapermen, these conclusions gradually become commonly accepted—while the many wild rumors that confuse the public opinion of the day, dissipate in the course of time.

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The history of the hydrogen bomb project is a classic of "leaks." First, John J. McCloy, former Assistant Secretary of War, told the National Association of Life Underwriters in December 1946: "From first-hand information given to me by scientists . . . there can be little doubt that within the next ten years, to be conservative, bombs . . . can be made . . . over ten times more powerful than the bomb dropped on Hiroshima, and if we can move to the other end of the periodic table and utilize hydrogen . . . we would have a bomb somewhere around one thousand times as powerful. I have been told by scientists . . . that, given the same intensive effort which was employed during the war . . . we were within two years of producing a bomb of the hydrogen-helium type."[1]

Three years later, Senator Edwin C. Johnson of Colorado, member of the Joint Congressional Committee on Atomic Energy, while chiding scientists for their "yen" to tell secrets to the world, took the audience of a nationwide television program into his confidence, telling them that American scientists already had produced atomic bombs with a power six times that of the Nagasaki bomb, and that they were working on a "super-bomb" a thousand times more powerful.[2]

Another three years, and the newspapers all across the United States blossomed out with eyewitness reports—with sketches—of the explosion of the "first hydrogen bomb," at 7:14 A.M. on November 1, 1952, during the secret Eniwetok tests.

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Scientists all over the world knew, ever since the first atomic fission bomb was exploded, that such a bomb could conceivably be used as a detonator to explode an immensely more powerful "thermonuclear" or "fusion" bomb. In fact, several physics texts (for example, Gamow's *Atomic Energy*, 1946) have discussed this possibility in some detail. How little "classified information" was needed to perceive this possibility, was exemplified by Thirring's *History of the Atomic Bomb*, a book published in Vienna in 1946. Chapter 42 of this book,[3] entitled "The Superbomb," presented a lucid and valid analysis of ways in which thermonuclear explosion can be brought about.

Atomic scientists, and the *Bulletin of the Atomic Scientists* in particular, have leaned over backwards, (we are now inclined to feel, needlessly) to avoid attracting world attention to the dreadful possibility of atomic "superweapons." The *Bulletin* first published a translation of Thirring's paper in March 1950, when Senator Johnson's bombshell, and the subsequent discussion in the general press (ending with the January 31, 1950, announcement by President Truman), had made fur-

[1] *Bulletin*, III (January 1947), 5.
[2] *Bulletin*, VI (March 1950), 66.
[3] *Bulletin*, VI (March 1950), 69.

ther reticence pointless. The April 1950 issue of the *Bulletin* contained papers by two distinguished American scientists, H. A. Bethe, and L. Ridenour. The analysis of the problem of thermonuclear weapons, given in these papers, was one which *any* good nuclear physicist in *any* country could have made, at that time, on the basis of publicly available scientific information; nevertheless, the appearance of Bethe's article caused a memorable storm in the Atomic Energy Commission, because of the author's close association with the Los Alamos Laboratories.

The most important 1950 addition to Thirring's 1946 considerations was the entry into the picture of the "super-heavy" hydrogen, tritium (T)—in addition to the previously considered, more common "heavy hydrogen" or deuterium (D). Weighable amounts of this new, artificial isotope of hydrogen were first produced in the atomic pile after 1946. Although the Atomic Energy Commission has never commented on this point, it has been assumed by many, ever since the 1950 discussion, that only the use of a tritium + deuterium (T + D) reaction as an "intermediate detonator," itself (to be set off by a fission bomb), can make the ultimate aim of explosive fusion of two deuterium nuclei (D + D reaction) technically possible.

The T + D reaction can occur at much lower temperatures than the D + D reaction, and releases more energy. One may therefore ask: Why not rely entirely on this reaction? This is not practical because to produce a tritium nucleus one has to use up pile neutrons which can also be used to produce plutonium from uranium; and the explosive energy of an atom of plutonium (100 million electron volt) is higher than that of the pair T + D (17.6 million electron volts). The only advantage of developing a thermonuclear bomb, powered substantially by tritium, would be the possibility of increasing practically indefinitely the explosive power of a single bomb—at the cost of reducing proportionally the total number of bombs in the stockpile, and that is hardly a strategically desirable objective. Furthermore, production of plutonium is more desirable than that of tritium because the former is practically indefinitely stable, while the latter is comparatively short-lived (one-half of it decomposing every twelve years).

If, however, the thermonuclear bomb could be made to derive its energy from the D + D reaction without tritium, or with only a little tritium serving as a "booster," then the possibility would be opened to increase enormously the power of individual bombs without (or with only a relatively small) loss in the total number of available bombs.

Press comments have generally assumed—although this, too, has never been officially confirmed—that the giant AEC plant at Savannah, Georgia, now under construction, is intended for the production of tritium by neutron bombardment in atomic piles. However, it has been stated that like the Hanford piles, the Savannah piles could also be used to produce plutonium, if large-scale tritium production proves to be unnecessary for the thermonuclear weapons program.

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The main problems that had to be solved in building thermonuclear bombs, can be imagined without access to secret information. The fission bomb has to be increased in power until able to produce a temperature high enough to initiate a D + D or, at least, a T + D reaction. A method had to be found to compress the fusable hydrogen isotopes as densely as possible in a container close to the detonator, and to keep it together for a sufficiently long time, after the explosion of the latter, to catch "nuclear fire."

According to unconfirmed reports, the problem of increasing the power of a fission bomb sufficiently to make it theoretically capable of serving as a detonator for a thermonuclear bomb, was already solved in the 1950 Eniwetok tests. The next indicated step was to combine the detonator with sufficient amounts of fusable hydrogen isotopes to be able to detect, beyond doubt, the contribution of this component to the total explosion energy. This may have been achieved in the 1951 test.[4] From there on, the amounts of fusable material in the bomb could be increased in steps, until it would become the main explosive ingredient, and the fission bomb would be relegated to the role of a "percussion cap."

The Eniwetok "experiments" of 1952 must have been a step in this progression. Whether the 1952 explosion was that of a true "hydrogen bomb" depends on definition. If, for example, we decide that when the power of the "fission detonator" is more than doubled by the "fusion shell" we will call the whole a fusion bomb, then the descriptions of the eyewitnesses of the November 1 explosion seem to indicate that this requirement has been now satisfied. Heat and light effects noted—according to these descriptions—at a distance of 30–35 miles from the explosion, have been reminiscent of descriptions, in the past, of fission bomb explosions witnessed at distances of the order of ten miles or less.

[4] See for example statements of Lt. Gen. E. R. Quesada, reported in *St. Louis Post Dispatch* on October 30, 1952.

ANNOUNCEMENT BY THE CHAIRMAN UNITED STATES ATOMIC ENERGY COMMISSION (November 16, 1952)

Joint Task force 132, operating for the Department of Defense and the United States Atomic Energy Commission, has concluded the third series of weapons development tests at Eniwetok Atoll in the Marshall Islands. Like the GREENHOUSE series 1951, it was designed to further the development of various types of weapons. In furtherance of the President's announcement of January 31, 1950, the test program included experiments contributing to thermonuclear weapons research.

Scientific executives for the tests have expressed satisfaction with the results. The leaders and members of the military and civilian components of the Task Force have accomplished a remarkable feat of precision in planning and operations and have the commendation of the Department of Defense and the Atomic Energy Commission.

In the presence of threats to the peace of the world and in the absence of effective and enforceable arrangements for the control of armaments, the United States government must continue its studies looking toward the development of these vast energies for the defense of the free world. At the same time, this government is pushing with wide and growing success its studies directed toward utilizing these energies for the productive purposes of mankind.

STATEMENT BY DR. JULES HALPERN

Chairman, *Federation of American Scientists*

"The evident progress in thermonuclear weapons research reported by the AEC and the press drives home with renewed force the need for some alternative to the present armaments race. We may be sure that we are not the only country engaged in such research. We must have no illusions of security based on monopoly of a superweapon. In fact, no nation is secure against the hydrogen bomb, and our people must realize that the threat is nowhere greater than here. The kind of security we need and want can be had only by building a stable peace.

"Our country must distinguish between the false security of bombs and the genuine security, which requires a slow, step-by-step, but positive approach to peace by mutual agreement, by gradual disarmament, and by world-wide economic reconstruction and development.

"The nations of the world are loading the balance with a terrible weight for destruction. A greater weight must now be found for the side of real security and peace.

"Almost three years ago, we urged establishment of a top-level commission with broad perspective to make a fresh start on our atomic policy. A State Department advisory panel has this objective in part, and release of their findings is eagerly awaited. The entire problem must be a matter of the first and most urgent consideration by the new administration. Efforts toward international atomic control must be pushed forward in spite of present obstacles. The AEC announcement is a sober and grim reminder to the world that a way must be found to prevent the use of these and even more potent weapons to come."

In a rather detailed "preview," published in the *Saturday Evening Post* on October 25, 1952, S. Alsop and R. Lapp said that the power of the hydrogen bomb to be exploded at Eniwetok "perhaps before these words are printed," will be "more than ten times" that of the Hiroshima and Nagasaki bombs. They also estimated that the blast-damage area of this bomb will be 45 square miles, the heat-flash burns area 75 square miles, and the deadly radioactive damage area, 4.5 square miles—as against 7, 10, and 2 square miles for the Hiroshima bomb, and 25, 35, and 3.5 square miles for the most powerful present-day fission bombs. We must leave these figures to the responsibility of the reporters; but the descriptions of the eyewitnesses are, at least, in no flagrant disagreement with them.

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All informed commentators on the November tests stressed one point: The explosions were what the AEC release described them—"experiments" in thermonuclear weaponeering. J. R. Oppenheimer, the outgoing chairman of the General Advisory Committee, acclaimed the H-bomb experiments as "very remarkable technical developments and technically a really impressive piece of work."

Dr. L. A. DuBridge, another outgoing member of the General Advisory Committee, commented, according to the *Los Angeles Times,* that thermonuclear weapons clearly are weapons in the research stage, and weapons in the research stage are not weapons ready for actual use.

Dr. Vannevar Bush recalled, in his commentary, that "in 1942 we had an experiment and in 1945 we had the atomic bomb."

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It seems, however, that there is little doubt, that in principle, at least, the technical feasibility of thermonuclear bombs has now been demonstrated. It will be noted that the estimate of the scientists, who informed Mr. McCloy in 1946 that it would require about two years of intensive effort to produce a hydrogen bomb, has proved as correct as their 1941 prediction that it would take four years to make the first fission bomb. (The estimate of those scientists who figured in 1945 that it should take the Soviet physicists about four years to explode their first atom bomb,[5] also was borne out by events.)

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To what extremes of destructiveness thermonuclear weapons will yet rise—whether they will become 100, 1,000 or more times more powerful than the fission bombs—we do not know. It is a problem of technical feasibility and strategic advantage (if any), weighed against costs. The influence of the advent of these weapons on the course of political and military history, is a subject that was anxiously discussed in 1950. It is time to renew this discussion—even though the general reaction to the long anticipated event has been one of exhilaration about a new America "first," and complacent hope that now, finally, we have reached an extreme in terror weapons, that will serve as effective deterrent to anybody intent on starting a war.

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Comparison of the terse official "information" and the much more detailed picture available from the combinations of "leaks" with expert analysis, inevitably leads to the question of whether the extreme secrecy imposed officially on the whole thermonuclear weapon development (and the same applies to other areas of the atomic energy program, such as the "tactical bombs") is reasonable. The necessity for intelligent planning, in particular for home defense (but also for the whole national and Atlantic Pact collective military program), is a potent argument against present policy. It has been raised in the past, and must be raised with renewed emphasis now. The difficulty cannot be evaded by communicating some secret data to a few top leaders in Civil Defense, or to top planning staff members of the NATO. Whole nations and their representatives—in the United States Congress, in the British Parliament, in the French Chamber of Deputies, etc.—are called upon to make great efforts to organize for unity and defense, not knowing the essential factors, either of their own strength, or of the threat that hangs over them.

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The ones against whom the secrecy is directed, undoubtedly know at least as much as qualified analysts can reconstitute here, and probably much more. Nevertheless, the arguments for

[5] F. Seitz and H. Bethe, "How Close Is the Danger," *One World or None* (New York: McGraw-Hill Book Co., 1946).

keeping the official releases as terse as they are now, probably are twofold. In the first place, "you never know." Perhaps, the Soviet leaders and their experts are too stupid to make logical deductions from known facts; at least, they might have been blind in one particular case, so why help them? In the second place, the smaller you keep the officially illuminated area of information, the earlier begins the penumbra of deductions and guesses, of speculations by experts, and reports by secret agents. However shrewd and well-informed the first ones, and however well-placed the second ones, they can provide only more or less probable conclusions, never certain knowledge. Make a few more facts official and, starting with them, expert deductions and agent reports will penetrate that much deeper into the darkness.

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These are, then, the two sides of the argument: We undoubtedly confuse and hamper our potential enemies by maintaining extreme official secrecy on our atomic weapons development; equally certain, we damage our own progress, make the democratic system of policy-making illusory in our own country, and hamper the united effort of the noncommunist world. Which is the more important consideration?

—E. R.

Eyewitness Stories of the Bomb Test

LETTERS from different eyewitnesses of the November 1 test explosion have been published, first in the *Los Angeles Examiner* on November 8, then in *Lima News* (Ohio) on November 10, in the *Michigan City News Dispatch* (Indiana) on November 11, the *Daily Pantograph* (Bloomington, Illinois) on November 13, the *Salt Lake City Desert News* (Utah), and other papers across the nation. According to a summary of these letters, taken from the *New York Times* of November 15, the bomb "had been transported to San Francisco under heavy guard, where it was loaded on a Navy vessel and placed in a special compartment. The door was welded shut and heavy chains were welded across the door.

"Federal Bureau of Investigation agents accompanied 'the bomb' aboard ship, and there were more civilian and security personnel aboard than sailors. There was a moment's anxiety when the ship's electronics gear picked up what was thought to be an unidentified submarine, but one letter writer said 'nothing came of it.'

"The ship carried 'the bomb' directly to the test island, apparently an atoll some thirty-five miles from Eniwetok in the Marshall group, where most United States atomic tests are held.

"The test island apparently was about three miles long and somewhere between one-quarter of a mile and one mile wide, although the description of the island varied in the letters.

"Vessels of the task force were scattered in an area around the island with the closest stationed about thirty miles from the center of the explosion, the letters said. Several ships apparently were thirty-five miles away.[1] There was no indication whether land observers were closer to the scene.

"But the letters clearly showed that the explosion took place on November 1 with zero hour at 7:15 A.M. Eniwetok time.

"Aboard the ships the men had donned protective clothing and had been instructed to turn their backs to the island ten seconds before the blast, close their eyes and cover their faces with their arms.

"At 7:14 A.M. a voice over the loudspeaker of each ship started counting the seconds. During that time, one observer wrote home, everything was quiet. He said:

" 'In those last few minutes, especially when they were counting off the seconds, we all grew real tense and silence was so perfect you could hear a pin drop. In those last few seconds, I think everything I've been told ran through my mind. And in the last second, I said a silent prayer. . .'

"For six seconds after zero there was silence, no movement, no flash in the sky.

"The first sign of the explosion came to the men aboard ship in the form of a flash many times brighter than the sun, followed by a wave of heat across their backs.[2] Although the men had their backs turned with their arms across their dark glasses, the blinding light was not kept out.

" 'It would take at least ten suns' to equal the light of the explosion from a distance of thirty-five miles, a navigator wrote.

"Ten seconds after zero the men on ship started turning around to face the direction of the blast.

" 'I could hardly believe my eyes,' one wrote. 'A flame about two miles wide was shooting five miles into the air. This lasted for about 7 seconds. Then we saw thousands of tons of earth being thrown straight into the sky. Then a cloud began to form about twenty seconds after the shot.'[3]

" 'You would swear,' another sailor wrote, 'that the whole world was on fire. It was really something I'll never forget.'

"At least three eye witnesses reported that the test island on which the bomb had been exploded disappeared after the blast.

" 'About fifteen minutes after shot time, the island on which the bomb had been set off from, started to burn and it turned a brilliant red. It burned for about six hours. During this time it was gradually becoming smaller,' one man wrote. 'Within six hours an island that had once had palm trees and coconuts had now nothing. A mile wide island had disappeared.' "[4]

[1] One letter said the sound wave hit the ship two minutes after the explosion, which compounds to a distance of 40,000 meters.

[2] One observer said the heat wave that hit his back was "about 180° F." Another described it as a "momentary touch of a hot iron."

[3] Several observers described the shape of the "mushroom cloud" as about a mile wide at the bottom and at least thirty miles wide on top. One said it went fifteen miles into the air. Several noted that it had several rings in addition to the top crown and likened them to branches of a pine tree. The Lima witness gave a sketch showing two "rings"—the bottom one red and grey and the top one orange and white, and a top cauliflower-like all-white crown.

[4] The description of the five-hour-long "burning of the island" has caused much confused commentary. No nuclear reaction can last for more than parts of a second and minerals and rocks cannot undergo chemical "burning." Coconut palms and the matting they form on the ground can burn a long time. How much rock material of the island could have been molten to lava and chemically decomposed by the heat of the blast depends on the height and power of the explosion, but one remembers the "atomsite" glassy material that covered the ground below the explosion tower in Alamogordo in 1945.

Will Science Continue?

H. J. MULLER

The article below was originally addressed to a group of young people with a "scientific bent." The author considers the chances for the continuance of science in the light of the historical development of man. Dr. Muller is professor of zoology at Indiana University.

ONE day, early in the nineteenth century, a boy about sixteen years old was picked up on the street, in a dazed and decrepit condition, in the town of Nuremberg, Germany. According to the story which this boy, known as Kaspar Hauser, later gave out—but which may not have been a true one—he had been kept a prisoner in a dark cellar, without room to stand up, since infancy. Food had been thrust in at him, but he had been given no opportunity to learn to speak, to write, or even to walk, until a few months before his release. Finally the man who owned the house, after giving him some simple instructions in speaking and writing, moved away, leaving the door of the cellar unlocked. As Kaspar had not even known that an outside world existed he was bewildered when it burst upon his view. Not being feeble minded, however, he quickly learned the uses of objects and the ways of people. But the strain of it all gradually proved too much for him, his maladjustments led to quarrels, and after a few years he met a violent death. Whether this was by murder or suicide has never been definitely established.

The situation described by Kaspar Hauser in his story of himself is in a way paralleled by that of the whole of humanity in the past few centuries, although it is to be hoped that the ending will not be similar. For ages we human beings have remained cooped up within blank walls of ignorance and superstition, knowing of nothing beyond our immediate view and imagining at most another cell or two much like our own, on the other side of the wall. However, surprisingly enough, we have managed to creep through crevices in this dungeon and have at last gained a view, for the first time in all history, of the brilliant world of reality outside. It stretches far beyond our immediate reach, yet it is ours to roam, and in considerable measure to master for our own benefit, if we only would set ourselves to it.

For us humans, suddenly confronted by the immensities of the stars and galaxies with their multitude of worlds so unknown to our ancestors, the universe has expanded explosively almost overnight. But, in addition, there has been a kind of *im*plosion of the whole of nature, of comparable significance. That is, there has opened to our view a marvelous extension of matter inwards, and we have discovered microcosms, one world within another, in the interiors of all parts of all things. These worlds too are bringing to view unlimited vistas for exploration and conquest, and unsuspected avenues of power. Finally, the cosmos has opened tremendously in still another dimension, that is, backwards and forwards in time, and also inwards in time, just as in space. The interpretation of ordinary events in terms of complicated series of operations occupying fractions of microseconds remains an unknown book to many laymen. Moreover, they are hardly yet beginning to take seriously the enormous reaches of time behind us and before us, as compared with our primitive conceptions, and the amazing transformations which all matter, but especially living things, have imperceptibly undergone and will undergo during these stupendous ages. And they still regard with mystification the elusive, underground operations which secretly and slowly bring about these great changes, yet which, when brought to light, become more and more subject to human control, both as to speed and as to direction.

The Path of Scientific Development

Man, in the sense of an erect, ground-dwelling animal, who makes fires, shapes tools, speaks, and practices other techniques and social customs handed down from his ancestors, is known to have existed for hundreds of thousands of years, and man of our own species, not to be distinguished anatomically from present men, and probably about as able mentally, has existed for at least several tens of thousands of years. Why then is it only in our time, broadly speaking, that man has become aware of the kind of world he is living in? It is instructive to look for the reasons why science did not get on its feet earlier.

Before men could attain this kind of second sight high technologies had to be developed, which relieved men of some material cares and enabled them, in this leisure time, to make reliable observations, measurements, and deductions. At the same time, they had to have good means of communicating and recording their findings, for the work is so great that it must be a joint one. And there had to be a mental atmosphere which stimulated such activities and encouraged the expression of new ideas and the development of new methods, instead of stifling them. These techniques and this atmosphere took an enormous time to develop to the high level where real science emerged, with a systematic, consistent body of fundamental principles for interpreting nature. The delay in the emergence of science itself was caused not only by the fact that so many physical and

mental tools were prerequisite for it, but also by the fact that these technological developments happened only in relatively short spurts. That is, there were long intervals in between, of virtual stagnation or even retrogression.

Agriculture and Urban Life

The path of progress has been an exceeding long and intermittent one. Some 8,000 years ago, after the hundreds of thousands of years during which men lived as savages, an important spurt occurred, when some men rather suddenly developed agriculture and more or less settled living. There was another spurt 5,500 years ago when in the Middle and Near East intensive farming, aided by the invention of metals, gave the surpluses that made possible city life, with organized states and many specialized artisans. But this remarkable burst of progress of about 3,500 B.C. soon bogged down. Its winnings became increasingly drawn off, by the rulers of the top-heavy autocracies and theocracies of that day, to support them in a sterility that became ever more grandiose, wasteful, and given to war. The only knowledge which then remained respectable was the so-called "higher learning," dealing mainly with such things as astrological forecasts, mathematical mysticisms, sacrificial rites, medical charms, and incantations. Only this kind of learning was considered worth writing down. Any skills and knowledge that involved work with the hands were left to miserable slaves and craftsmen. These despised wretches had little energy left for discovering or trying out improved methods. Nor had they adequate incentives to make these improvements, for they could seldom better their own lot by this means; in fact, even to propose modifications in small matters of method was often a risky heresy. Neither could the craftsmen effectively pass along to others any improvements which they might succeed in making. Under these circumstances routine ways of doing things became thoroughly fixed and prescribed, and routine ways of thinking even more so. In short, authoritarianism and obedience became the unquestioned order of life. Such civilizations inevitably faltered and after a time most of them became disrupted by barbarians who had meanwhile learned much of the physical techniques.

In the ensuing dark ages, however, the core of these techniques survived. Finally, a new era of progress set in, often among the former barbarians, because these peoples were less hampered by the heavy weight of perverted tradition. And when this happened the advances in civilization could start from a higher level, and then reach to a higher peak than the previous wave of progress had been able to do. Yet time and again, after such a promising renewal, stagnation, decay, and dark ages set in once more. The archeological record, interpreted in the light of observations of human motivation and of the workings of societies, appears to support the inference that the reasons for such declines of highly organized societies were always fundamentally the same —the throttling of progress from above. And the times of substantial advance were on each occasion limited to a few hundred years, while thousands of years usually intervened between the spurts.[1]

The last period of considerable progress before that of our own time culminated in the classical Greek world of several hundred years B.C. Not until then had the advances in technique become great enough, widely enough diffused among the common people, and coupled with enough healthy disrespect for authority, to allow a few men to begin to search for new insights into nature. But again knowledge tended to become a "higher learning," a caste system developed, society became more autocratic and it finally fell under the deadening hand of Imperial Rome. We all know of the long ages of darkness and superstition which ensued that time.

The Renaissance

Finally, when in the later Middle Ages, masses of people in Europe found themselves again in a position to better their own lot, they had, to start with, a higher general level of technique, diffused over a wider area than ever before. In addition, they were provided with certain major innovations, most of which had originated outside of Europe but the uses of which were greatly developed by Europeans. Among these was gunpowder from China, which helped to make knighthood with its oppression of the common people obsolete and thus to give them new freedoms of action and thought. Then there was the compass, also from China, which enabled men to travel far and wide, getting new ideas, knowledge and techniques, unsettling ancient misconceptions, and through commerce and colonization deriving material advantages which increased their well-being and leisure. Important too were paper and printing, once more from China, that enormously multiplied the transmission and recording of ideas. Our modern so-called Arabic number system, derived from India via the Arabs, was a necessary basis for the computations so essential to modern commerce, industry, and science. The establishment of universities, which seem first to have taken solid root in India and which later had been set up in the Moslem world, was copied in Europe and helped much to disseminate and increase knowledge.

There was also a ferment of ideas caused in Europe as the ancient Greek writings became known again and, not long after them, the achievements in arithmetic and algebra and the valuable observations and data concerning the human body, concerning many kinds of substances, and concerning the sky, which were being contributed by the Persians, Arabs, Moors, and Jews of Moslem countries. With the betterment of communication and transportation, the decline of banditry and petty warfare, the improvement of agriculture, and the rise in living standards and (though not excessively) in population, all these factors and others met and mingled in Europe, with increasing productiveness.

One reason why, in Europe, these acquisitions of technique and knowledge were utilized productively and in such a way as to give rise to still further advances, was that there were certain elements favorable for this in its mental background. One of these was a persistent spirit of enterprise, partly barbarian in source, which all the load of medieval oppression had not been able to quell completely. Another was the fact that the basic principles taught by Jesus, and long since adopted by Europe from the Near East, stressed the potential worth and the dignity of the ordinary human being everywhere and at the same time inspired in him a spirit of fellow feeling, cooperation, and pride in good works for others. The gradual strengthening of the rights of

[1]Good accounts of these alternate waves of advance and stagnation are given, for example, in the books by the distinguished British archeologist, Gordon Childe, *Man Makes Himself*, and *What Happened in History*, obtainable in thirty-five and sixty-five cent editions of the Mentor Book and Pelican Book pocket-editions, respectively.

people of humble birth, achieved by hundreds of years of effort on their part in Europe, was undoubtedly helped along by this way of thinking. As a result, people had more opportunity and incentive to improve their condition, their welfare was advanced, and human potentialities were enhanced in many ways. All this was very important in providing conditions favorable for the betterment of techniques, and the rise of science. It is true, however, that there were also powerful influences opposed to progress exerted by authorities of the Middle Ages in the *name* of Christianity, such as fanatical dogmatism, and the withdrawal of attention from the righting of present evils by promises of post-mortem rewards. In spite of these reactionary pressures, the current of progress proved the stronger one, and became self-increasing. With it, for the first time in history, sound theoretical science was able to raise its head effectively. Our present industrial civilization is mainly a by-product of that science.

Precondition for Continued Advance

We ourselves are still in the upswing of this wave, although the forces of autocracy throughout much of the world, feeding on the very successes of science, are also growing more menacing. Whether our new material and social techniques and our deeper understanding of the whole situation will this time manage to subdue the parasitic growth of autocracy is a question that still hangs in the balance. Let us examine some of the conditions on which the decision depends.

Broad Social Base

A few great minds did concern themselves with scientific questions among the ancient Greeks, but if science is to develop actively it needs more support than a few great minds. It needs the very broad human base which only highly developed techniques, coupled with generally high living standards, popular education, and considerable freedom of expression can provide. It thrives best where people have ample opportunities to better their physical welfare, and where at the same time they have incentives for using their own minds and hands to devise new or improved methods, to discover new facts and interpretations, and to criticize or modify old ones. This presupposes considerable freedom from oppression, physical or mental, and a social system of an essentially democratic kind where the individual can develop his own peculiar potentialities for good, even where this means the challenging of established opinions. That is, one must even have *the right to be honestly wrong*.

This broad human base is necessary not only to furnish the physical surplus required for scientific research, and the refined tools which science needs, but, just as important, to provide a great educated public for encouraging and supporting science, both theoretical and applied, and for generating a sizeable scientific personnel. For the progress of modern science, in fact, the public at large should be educated to understand and sympathize with the methods which science uses, with its major accomplishments in all directions, and with its attitudes of mind and its aims. A public ignorant of these things is much more likely to receive the findings of science with hostility, to withhold the large-scale physical and moral support required by present-day scientific work, and to refuse to grant it the wide freedoms which it needs in choosing its directions. Moreover, unless the public as a whole is educated in this way, many of those who would have found their most useful work in scientific and technological fields will be shunted off into other, less productive and less satisfying activities.

A Large Scientific and Technical Staff

One reason why, for the advancement of science, a large number of people engaged in scientific and technological activities of varied kinds is necessary, and not simply a few prominent scientists, is because so much labor is required for gathering all the information needed, for laying bare difficulties and problems, and for improving methods to the point where important discoveries are possible at all. Another reason is that in countries where many people are drawn into such work the chances are far higher that, included among them, will be those persons who are capable of making the greatest discoveries. By way of contrast, in countries where such work is confined to a few, the chances will be far smaller that any of the numerous persons who could have made great contributions to science and technology will ever have the opportunity to develop this capability and put it to use. Large numbers of scientific and technological workers are also needed because, after any important discovery has been made, new fields are opened up by it, and many men are then required for developing these fields, subjecting them to criticism and refinements, coordinating them with other fields, and bringing out their numerous practical and theoretical applications.

Those of the large corps of technicians and scientists who do not achieve much individual recognition by the public need not have the feeling that they have been at fault. Often it is mere accident that one of them and not another is in the position where he can make the spectacular find or invention. Be he ever so original, he must always build upon a great amount of work that went before him (whether he cites it or not!) and an equally great amount of work after him is often necessary for the contribution's full fruition. Thus all who work in science or in the technological fields which are necessary to support, supply, and apply science can feel a pride of accomplishment whenever any member of their brotherhood makes a "strike." Moreover, the public at large, once it has become generally educated in things scientific, and realizes the important part which it, the public, plays in scientific development, will itself feel a justified thrill in the victories of its scientists. This will lead to the acquirement, by all humanity, of a new, invigorating sense of the richness and hopefulness of life.

Freedom from Pursuit of Exclusively Practical Ends

In considering what types of scientific and technological work are most worth while, it should be recognized that there are few cut and dried categories in science. The scientific work of one field shades off into another and combines with it, and theoretical work shades into the practical. A medical man, an engineer, or an agriculturist, although an applied scientist, can often hit upon facts or devise instruments or methods which are invaluable in theoretical researches. On the other hand, it is also important to realize that those discoveries which turn out to be of most revolutionary utility in the long run, and of widest applicability too, are often not the ones which were attained by striving for some definite practical end. They are

the ones which were found in following up the quest for truth in its own right, with the aim of gaining deeper insights into the basic operations of nature.

No one could foresee, for example, that the "highbrow" conclusion that the earth is round, based on observations in pure astronomy, combined with far-flung theorizing would result in the discovery of America and Australia and the complete reorganization of world economy. Only Soddy in the first decade of this century foresaw and stated publicly that the discovery of radioactivity and isotopes marked the beginning of a revolutionary road to the control of atomic energy. The laboratory finding of radio waves by Hertz in the nineteenth century was not at the time realized to be the fundamental discovery on which would be based radio and radar and television. Pasteur was nearly failed in medical school because he wasted his time—so it was thought—on those speculations concerning the asymetrical combining property of the carbon atom which are basic to the achievements of modern organic chemistry, with its growing myriads of compounds and processes so indispensable to us today. The pursuit of seemingly impractical studies on the laws of Mendelian heredity made possible the development of hybrid corn and poultry, worth hundreds of millions of dollars a year to American farmers. And so we could go on and on.

It is said that when, about a century ago in England, Faraday—who by the way had been the son of a blacksmith—was explaining at a lecture the fundamental discovery he had just made of the connection between electricity and magnetism, a lady in the audience interrupted him to ask: "But, Mr. Faraday, what is the use of this knowledge?" Faraday was taken aback for a moment and hesitated. Then he came back with a counterquestion: "Madam, of what use is a baby?" As we all know today, this baby of Faraday's later developed into dynamos and power lines, electric motors, telegraphs, telephones, electric typewriters, washing machines, and all the innumerable devices by which electric power is utilized to perform work for man. At the same time, the principle that had been disclosed served as one of the necessary bases for those great advances in physics and chemistry centering around the electromagnetic nature of light and other radiation, the

properties of atoms, electrons, and atom nuclei, and all the practical applications of these fields of knowledge. This is an instructive illustration of the way in which so-called pure science, the discovery of seemingly impractical fundamental truth, primarily for the sake of knowing what kind of a world we live in, so opens man's eyes as to enable him to guide his hands and feet to the conquest of new worlds. This is one reason why such an institution as our National Science Foundation, having the objective of giving support to basic theoretical studies regardless of whether or not they seem practical, should be regarded as representing the payment, by society, of but a tiny part of its debt to theoretical and "impractical" science.

It should be realized that although few discoveries can be as important as the theoretical ones just mentioned, nevertheless each contribution fills its indispensable place in the great organism of modern science. For only by the interactions of its many parts, fittingly coordinated, is this organism able to function properly, both in interpreting the operations of nature and in controlling them. Much of this work is bound to be toil and drudgery, as well as the following up of false leads, just as most of the work even of an explorer is a grueling grind. In both cases, however, this routine is ennobled by the fact that the spirit of the great adventure as a whole suffuses into each part of it. In the case of science, adventure is an enterprise on which all humanity is embarked and it is leading us to ever wider freedoms.

Causes of Retrogression

The view of the situation for science which has just been sketched is founded on the assumption that science will continue to advance, and to be used for human betterment. Yet we all know that the threat of world-wide catastrophe is raising its head and that this monster will itself make use of weapons provided by science. Have we then reached the peak of our present wave of progress?

If we may judge from such knowledge as exists concerning all the previous occasions on which civilization has been seriously set back, the fundamental reason, as we saw in the earlier part of this discussion, has in each case been that the advantages accruing from the higher techniques, which had developed among the people in general, became more and more appropriated by a ruling group. The ruling groups were not themselves well acquainted with the more advanced skills and knowledge, nor with the methods and conditions of technical advancement but they were nevertheless able to misuse these techniques, to swell their autocratic power still further and to freeze into rigid form their own system of ideas. Meanwhile the bulk of people, divorced from their rulers, became increasingly subject to dictation and oppression, both physically and in their thoughts.

We see, then, that the fruits of cultural progress have repeatedly served to feed a parasitic cultural growth which, by its increase, has ultimately acted to hinder further progress. This process curiously resembles the ways in which organisms of a parasitic or predatory kind increase at the expense of the organisms which serve as their food. Eventually there is so much depletion of the supporting organisms that the parasitic or predatory group, too, declines, allowing the parent organisms to increase again. In the biological case, the mathematics of the resulting swing of the two types back and forth, in a series of waves, have been calculated by Poincaré, Gause, and others. The formulae which were worked out to express the shape of this continually wavering curve were then checked by observations on living material, and found to conform with them. It is tempting to infer (and I offer the hypothesis for what it may be worth) that the waves of human progress represent the operation of essentially similar principles, applying to cultural and economic rather than to purely biological elements. It is true that, in the human case, the waves are far less regular and are incapable of calculation, because the cultural elements are subject to such enormous qualitative variations and are bound in such a complex organization. This situation prevents any true repetition of previous states when

cultural changes occur. However, the essential conditions which in the biological cases give rise to the wave form—the existence of two self-multiplying groups, one of which draws its sustenance from the other—appear to be present likewise in the cultural examples.

The process of concentration of unlimited social power into the hands of a relatively small group, unrepresentative of the people in general, has already taken place in considerable measure, even in the lifetimes of the youngest of the readers of this article, in the countries behind the Iron Curtain. Because of the efficiency of modern techniques, it has occurred with a swiftness, to a degree, and on a scale, surpassing any previously known. Tragically enough, these developments took place in consequence of the people's attempt to achieve exactly the opposite result. The mistake they made was to put into power a complete dictatorship, uncontrolled by them, which became ever more ruthless in running the whole of society primarily in its own interests. At present the countries involved in it are nevertheless increasing their physical strength tremendously, and they may be counted on for many decades yet to make important scientific and technological advances in those directions which their rulers regard as serviceable for their own ends. However, the springs of free inquiry in theoretical science, from which the progress of the more distant future must eventually flow, have been seriously vitiated in those countries. For authoritarianism is in the long run incompatible with progress. And the brutality, stupidity, and sweeping character of the interference which some important branches of theoretical science, including fundamental biology, chemistry, physics, and psychology, have already suffered at the hands of this new authoritarianism, have demonstrated the hollowness of its claim that it, unlike the dictatorships of the past, is scientific in its spirit and methods.

In the meantime, the poverty stricken, ignorant millions in those vast regions of the world still outside the Iron Curtain who are without adequate modern machinery and techniques, have been greatly impressed by the growth in physical strength of the huge Soviet empire, and by the false promises that the social methods used there will better their own conditions of life. At the same time these peoples have been much embittered by the selfish colonial policies to which they were—until recently, at any rate—subjected by Europeans. And in their eyes Americans have now taken the place of Europeans. These just awakening peoples are therefore feeling more and more inclined to jump, as the Chinese have done, from the frying pan into the fire. We have had a shocking experience, in Korea, of what a powerful force against us they may then become, when supplied with equipment and instruction from the heartland of totalitarianism.

A Point Four World Program

We cannot afford to sit complacently back while this happens on a still larger scale, engulfing one country after another either by force or by hook and crook. Even if we were so selfish that the fate of the rest of the world meant nothing to us, the risk to our own freedoms would still be too great. On the other hand, a major war between the two halves of the world would entail such universal destruction as to make that risk to civilization also a most awful one. It is therefore necessary for us now to understand the situation of these peoples from their own point of view, to sympathize with them, and to use all means we can to show them that their interests and ours are in harmony. For it is the misery of this whole underdeveloped section of the world, the great majority of mankind, and not just the aggressiveness of Russia, which presents the most grievous social problem of today and tomorrow. And even if Russia were defeated, this problem of the "have-nots" would rise again to confront our children and grandchildren.

We must demonstrate to these suffering millions that we are on their side, that we believe in freedom and well-being for all, including themselves, and that we will help them to achieve it. More than this, we must realize that their advancement will be to our own material advantage in the end too, just as we have learned that, within our own country, high wages and a high standard of living on the part of the ordinary citizen are actually good business. They tend to keep the wheels of industry, agriculture, and commerce turning at a high rate and thus mean more prosperity for all in the end. For a considerable time to come, however, this policy with the outer world will mean additional heavy sacrifices on our part, besides those needed for direct defense for mere words are not enough for starving people. We must put real effectiveness into the so-called Point Four plan, and try in no grudging or condescending spirit to help these peoples to the attainment of more modern techniques that will have a really noticeable effect upon their living standards. This means giving them the benefit of our knowledge and experience concerning agricultural, industrial, and medical methods, and at the same time according them a significant amount of material support in the setting up of their factories, mines, waterworks, transportation systems, reforestation, and drainage programs, and so on. There is an enormous need here for the work of applied scientists and technologists.

Socio-economic Reform in Backward Areas

Aid in material techniques and goods is in many places likely to fail of its objective, however, unless the peoples receiving it can at the same time be encouraged to adopt more enlightened social and economic measures than they now have. For the persistence of parasitic landlordism, usury, and feudalism in general, which are so prevalent in the technologically backward portions of the world, tends to drain off the advantages of higher techniques so as chiefly to serve luxurious living by a few and to increase the power of the ruling autocracies. This is, after all, the ancient pattern which everywhere has resulted in the choking off of progress, and its existence in underdeveloped countries in the form of domination both by foreign powers and by their own feudal or semi-feudal overlords, is the primary cause of their having advanced so little in recent centuries.

The necessary policy must therefore include, among other things, the encouragement of such changes in practice and in point of view as would lead to the increase of material and mental freedom among the ordinary people of those countries. This means the distribution of land among the people, as occurred on such a grand

scale under the direction of our occupation in Japan, the establishment of democratic procedures in general, of the right to organize effective labor unions, and the setting up of adequate public schools and popular education at all levels. Along with this goes also the task of assisting in the introduction of modern scientific ideas concerning the universe and man. This does not imply that these peoples should be urged to adopt our particular economic, political, or ideological forms but rather that they be given a chance, themselves, to readapt their own cultures in enlightened ways, harmonious so far as possible with their own traditions—even as India is now so valiantly engaged in doing. We may rest assured that this will ultimately, without so much opposition as otherwise, mean the absorption into their own traditions of the elements of good in ours. At the same time, reciprocally, ours should be able to benefit much from theirs.

One of the most important scientific ideas, the recognition of which is essential if progress is to be made in these great areas of the world is that an uncontrolled increase in population is incompatible with a permanent rise in well-being. For if science saves lives only to make this rate of increase greater, as it has done in these countries in the past several decades and is doing at an increasing rate today, the end result can only mean greater misery and defeat for all their hopes of progress. But if all peoples learn to control their rate of increase, as Americans and Western Europeans have done in some degree, and to keep it well behind their increase in material productivity, then there is indeed great hope for their futures and much progress can be made by them within a short time. It has suited the purposes of the Russian autocrats to deny this need of birth control, for they wish the masses to grow bigger, more wretched and more credulous, the better to be able to use them for their own purposes and against us.

In all our dealings we must bear in mind that we have no valid grounds to assume that we are intrinsically superior to any of these other peoples. A few of the more important contributions of Oriental peoples were mentioned above. It may also be recalled that Central Africa was one of the first, if not the first, to begin the working of iron, one of the major achievements in the progress of civilization. We of European antecedents just happen to be on the upswing of our greatest wave, while these other peoples have been caught, till recently, in one of those much longer periods of comparative standstill. Thus it is up to us to help them, in all sincerity, to take their place along with us in the world-wide community of free and enlightened citizens. The time is woefully short for us to convince them of this, in view of their desperate plight and the rapidly growing influence which the totalitarians are exerting on all these peoples.

Improvement of Our Own Democracy

It will be an enormous aid in this great task of aiding world reconstruction if at the same time we continue actively in our job of getting our own house in better order. We must not overlook the existence, right here among ourselves, of forces of reaction which are seeking to limit freedoms in all directions, to narrow the distribution of the fruits of progress, to control thought and expression, and to strengthen further, relative to the rest, the power of those who already have great power. Discrimination against minorities is a part of this same tendency, and we must continue actively with our job of eliminating it. Moreover, it is especially necessary to eliminate it if we would convince the peoples of Asia and Africa, most of whom are dark skinned, that we are sincere in our show of friendship and brotherhood with them. All citizens, including those engaged in scientific and technological work, must become aware of these dangers and join actively in the efforts to put our own freedoms and our own prosperity on an ever broader basis, and to make them more secure. For it is true, as has so often been said, that "eternal vigilance is the price of freedom."

But if these principles are recognized by citizens in general, including scientists, then the age-old process which time and again has caused the standstill and decline of civilizations may hereafter be stopped in its tracks. For despite all our imperfections, there has never before among all the civilizations of mankind been such an extension of democracy and education, or so much economic and social strength on the part of the people in general, as there is in our own country today. Moreover, the eyes and tools of physical, biological, and social science, placed at the disposal of our unprecedentedly democratic social system, have introduced an entirely new element into the picture of human progress. For the first time we have become aware of the fact of evolutionary change, we can weigh to some extent the effects of scientific techniques and social processes, and our people can be given the knowledge and strength to influence these very processes in their own favor.

Strengthened Defense

Another duty of all citizens, and of scientists and technologists especially, is to help build up in ourselves and our allies strength against physical attack from without. It is true that if war should come *both* sides may then be defeated more grievously than any nations were ever defeated before in history. However, we have to take the long chance here and to do our best in this situation. For if we should fail to build up our physical strength in this crisis, then indeed we are practically bound to lose, with or without a major war. This is in fact the outcome for which the totalitarians are hoping. We know their manner of thinking well enough to be sure they would take advantage of our weakness. If allowed their way, they will of course do it gradually, by a process not of outright "official" war, but of intrigue, erosion, and wearing away, directed first at the less developed countries. Our own greatest hope is that, if we do build up our defensive strength, and if at the same time we demonstrate our good will and sincere helpfulness to the destitute peoples of the undecided countries, the crisis may remain stalled so

long that totalitarianism will begin to lose its appeal for them, and even to lose strength in its own homeland. There is still a great, repressed but in fact increasing yearning for freedom in the long-suffering population of the USSR itself, and this may finally be directed by these people against their own autocracy, so as to cause its moderation. In that case too there need be no war. This is a question which, with good luck, may be settled even in our own generation.

The Limitless Outlook

If at last, as we must hope, the ideal of a world community of free, well-educated, and prosperous citizens prevails, then the outlook for science and for further progress based upon science will be auspicious as never before. The long vistas still ahead stretch out far beyond our own horizon. It is only lack of knowledge and of imagination that still causes some men to think that we are nearing the end of the road either in the physical or biological sciences or in their applications.

Man is a minute mote in the vastness of nature. He has only just begun, through science, to see the world for what it is, and to find large-scale ways of controlling it in his long-term interests. If only he will settle the sorry, shameful conflicts between groups of his own kind, he may then proceed to contests with nature which are really worthy of him. In these contests it is first necessary to know, and after that to take action.

The fields open for the scientists and technologists of the future are such as to challenge the most daring imagination. The mysteries of the ocean and of the earth's interior have only been glimpsed. On other levels, our paths of progress lead into the inner recesses of the atom nucleus and into the structure and dynamics of all-pervading space itself. There will be those who find new modes of combination of atoms, molecules, and higher categories, who invent and fashion fantastic new substances with marvellous properties. Energy in its varied forms must be grappled with, tamed, converted, and stored, and the sun's rays themselves must be artificially trapped and harnessed. Undoubtedly, too, men will succeed in leaving the earth and setting foot on other planets, and will establish outposts in interplanetary space. Yet even these conquests would only be the beginning of man's expansion in the cosmos.

Whether man would be worthy of all this is a most important question, one which requires its own kinds of attack. In this connection we must not forget the biological and psychological sides in scientific progress. There are intricate worlds of coordinated members, one within another, right within our own bodies and within those of all other living things. These must be explored and their ways discovered in detail. With knowledge comes the possibility of control, and the conquest over living matter must be pushed as vigorously as that over lifeless matter. In some ways, living things present the most fascinating and multitudinous opportunities of all for exploration and exploitation. There are swarming populations both on land and in the water to learn about, and to remake into new Gardens of Eden. It is, for example, very likely that algae and other plankton will furnish our most valuable basis of food in the future, and that bacteria and other microorganisms can be "trained" for many useful ends besides those which they already fulfill.

Finally, we must face the problems of human nature itself, for these present us with the greatest tasks of all. We shall then find that the transfiguration of man, by man himself, into a being ever nobler not merely in body but, more important, in spirit, is a direction of progress which will require our utmost resourcefulness and wisdom, and which is never-ending in its possibilities.

You young people who are to be scientists or technologists, or who are to have anything to do with the teaching, dissemination, or utilization of science—and what truly educated man does not have some function of this kind today? You young persons with this fresh knowledge and skill, to whom this article is mainly addressed, are in a privileged position. By virtue of your education, and of the democratic society in which you live, you provide the eyes of the world, the hands of the world, and the hope of the world. Freed of age-old misconceptions, you, like a glorified and more wholesome Kaspar Hauser, are in the process of escaping, not into a realm of fable but, at long last, into the marvellous world of reality itself! It is you who, more than all others, may soon hold the more distant world-destinies in your hands. You can make us all become the ancestors of increasingly god-like beings. You and those who follow you may some day even be able to throw back an answer to the eight-hundred year-old verse of the disillusioned, cynical Persian mathematician and poet, Omar Khayyam, in which he complained so bitterly:

> Would I could take this sorry scheme of things entire
> And mold it nearer to the heart's desire!

Little did old Omar imagine, despite his own great contributions to science, that the time might come when you and your fellowmen would in fact be taking things into your hands, and bringing this miracle to pass. Your goals, not static but ever advancing ones, are literally no less than the stars, and yet not even the stars alone. They are the expanding universes both of inanimate nature and also of the living body. And paramount in the progression of the living body is that of the spirit which forms an inseparable part of it. It is with the improvement and ennoblement of this spirit that the greatest future exploits of science must deal.

"The Task of Science"

"The material of science is coextensive with the whole physical universe, not only that universe as it now exists, but with its past history and the past history of all life therein. When every fact, every present or past phenomenon of that universe, every phase of present or past life therein, has been examined, classified, and coordinated with the rest, then the mission of science will be completed. What is this but saying that the task of science can never end till man ceases to be, till history is no longer made, and development itself ceases?

—Karl Pearson, *The Grammar of Science*

Science and UNESCO

The Third National Conference of the United States National Commission for UNESCO was held in New York, January 27–31, 1952. Professor Maurice Visscher of the University of Minnesota and Dr. J. S. Nicholas of Yale were co-chairmen of "Work Group 9" which met to consider "The Opportunities for Scientists and Engineers to Contribute to Peace through the United Nations System." We present below a summary of the conclusions and recommendations of this Work Group.

Science and technology are by custom and historical tradition international cooperative enterprises. The scientific method is universal; accordingly, no group or nation can claim unique interest in it. The results of scientific study are of immediate or potential value to all nations. The promotion of science for its own sake is not the prime objective of UNESCO; however, the chartered objective of UNESCO cannot be achieved without encouraging or promoting both basic and applied science as a means to the ultimate end. The past achievements and the important role of UNESCO's work in the basic and applied sciences combine to urge that there be no reduction in the limited fund now allotted for the key items of the present UNESCO science program. Aid should be given to the following areas: technical assistance and the field sciences cooperation offices, grants-in-aid, international research laboratories, and documentation and scientific abstracting.

Evaluation of UNESCO's Grants-In-Aid Program

UNESCO's program of supporting jointly with other organizations international cooperative projects which either required international action or were of great importance to many national groups has proved effective in facilitating international cooperation of scientists and engineers. But there are continuing problems of evaluating this program, for a balance must be struck between basic and applied science as regards magnitude of support within a limited UNESCO budget. It is obvious that the assistance to medical and engineering sciences must be brought up to the level of support for the more basic sciences, and attention should be given in particular to the promotion of international cooperation in the agricultural sciences, if possible in cooperation with FAO (Food and Agricultural Organization). These additional activities should be supported, however, without diminution in subsidy to the basic sciences.

The Promotion of Cooperation in Research in Major Area Problems

The research efforts of UNESCO "to improve the living conditions of mankind" should emphasize work on improved food production, better utilization of minerals, metals, and other natural resources, wider use of technical skills, and improvements in public health. The Arid Zone Research Council already operating effectively may well serve as a model for activities in other fields. The establishment of a similar Research Council to consider the mineral resources problem on a world basis is especially desirable. There is an urgent need for international cooperation in the development of newer methods for the finding and utilization of mineral resources, for the known world's reserves of numerous essential metals would be exhausted inside of twenty-five years if the per capita use of metals in the rest of the world equaled that in the United States. In the view of the current U.N. program to raise the world's living standard, attention should be called to the dependence of the American living standard on metals and minerals.

Barriers to Exchange of Information and Travel

Unnecessary and undesirable restrictions on exchange of information and travel of scientists exist in certain countries, including the USA. Free exchange of information and facilitation of travel are both essential to scientific progress and human welfare. Any unnecessary restrictions are harmful to the advance of science and to promotion of international understanding and are consequently detrimental to the cause of peace.

The Trend Toward Increasing Isolation in Science in the United States

Studies of literature citations in scientific publication in the USA show an increased trend, to mention only U.S. research reports. Ignorance of foreign literature leads to wasteful duplication of work, slowing up the progress of science, and the failure to utilize discoveries for useful practical purposes. Scientific nationalism, even when due to ignorance, leads to international misunderstanding; hence the correction of this trend is important to the promotion of international amity. There are two important fields in which an attempt to reverse the present trend can be effectively implemented: through more efficient abstracting and indexing services on an international level, and through calling the trend to the attention of the academic profession.

Better Utilization of the Services of Engineers

The services of the engineering profession have not been sufficiently utilized in the UNESCO program, although close cooperation between UNESCO and world-wide engineering profession and between the engineering societies and other agencies concerned with international relations would encourage practical extension of UNESCO's immediate and long-range activities. More effective cooperation would result from the utilization of the advice of the major professional organizations in the selection of engineering personnel for foreign service. In order to be of greatest service in utilizing and sharing their special knowledge, the engineering profession could benefit from UNESCO's aid in determining the needs to be met, the general and technical knowledge desirable in engineers who are to participate, the manpower and resources available for participation in the projects, and the engineering programs planned on a world-wide basis so that future demands for engineering skills can be anticipated.

News and Notes

Atomic Secrecy

The British hope that more atomic information can be exchanged with the United States was expressed by Mr. Churchill in the House of Commons November 20. The Prime Minister said, "I hope we shall be able to have an opportunity of discussing matters of this kind with the United States government after the new President has taken office." The explosion of the British bomb at Monte Bello on October 3 has dramatized the costliness of the present restrictions. The *Manchester Guardian* of October 9 called the explosion "the outcome of an absurd duplication of effort, cost, and ingenuity," remarking that possibly "a joint effort would have left more men and resources available for work on the peaceful uses of atomic energy."

The *Guardian* article reminds readers that General Omar Bradley has pointed out "the absurdity of laws that prevent most of the North Atlantic Treaty Organization's forces in Europe from knowing anything about weapons which they may one day have to use." General Bradley has complained that there is a serious misunderstanding in Europe about the capabilities of atomic weapons. This has resulted in too great a reliance on them, with a consequent slow-down in Western European rearmament efforts. Some kind of sharing of atomic knowledge, the General said, is becoming a military necessity. British Lord Ismay, NATO secretary-general, reinforced this appeal for more information at a recent news conference at the Hague, where he said, "sufficient data is not made known to those who must be able to make serious plans."

American Atomic Energy Developments

Power for the Ohio Plant.—Fifteen private utility companies have signed an agreement to supply 1,800,000 kilowatts of power required to operate the uranium-235 production plant being constructed in Pike County, Ohio. The companies, which will form the Ohio Valley Electric Corporation, will design and construct within four years the largest power generating system ever built.

Philip Sporn, president of the American Gas and Electric Company, is president of the new corporation.

The annual costs of power when the plant is in full operation is estimated at $60,000,000. The power costs to AEC will be based on fixed charges and costs of the power generating facilities, operating expenses, and fuel. According to *Business Week*, the AEC "has nailed down one of the biggest bargains in years. . . . For it will cost AEC about 3.8 mills per kwh.—the equivalent, say, of a Brooks suit for $37.95."

In the interim period before the plant is in operation the corporation will make available up to 465,000 kilowatts of power from its existing systems for early operation of the new gaseous diffusion plant.

An interesting feature of the 25-year contract for power is the cancellation provision. It was recognized that a major shift in technology might make the gaseous diffusion process obsolete, or an improvement of the international situation might reduce the need for atomic arms. A two-year cancellation notice is therefore provided; if the notice is given during the first ten years after the plant is in operation, AEC will pay certain cancellation costs which are computed on an annually decreasing scale.

The fifteen sponsoring companies are: Appalachian Electric Power Company, Cincinnati Gas and Electric Company, Columbus and Southern Ohio Electric Company, Dayton Power and Light Company, Indiana and Michigan Electric Company, Kentucky Utilities Company, Louisville Gas and Electric Company, Monongahela Power Company, Ohio Edison Company, Ohio Power Company, Pennsylvania Power Company, Potomac Edison Company, Southern Indiana Gas and Electric Company, Toledo Edison Company, and West Penn Power Company.

The cost of the project will be from $370,000,000 to $440,000,000. The money to finance the construction will be raised by the sale of $20,000,000 in equity securities to the various sponsoring companies and by sale of debt securities to institutional investors.

Five companies have signed contracts to supply more than 7,000,000 tons of coal annually to the two big plants which are to be built near Gallipolis, Ohio, and Madison, Indiana.

Atomic Power.—Eleven new companies have joined the Dow Chemical Company and the Detroit Edison Company in their joint study with the AEC of the development of a nuclear reactor to produce power. (The Dow-Edison project was discussed in the November *Bulletin* by Walker L. Cisler, president of Detroit Edison.) The Commission has announced that security clearances will be granted to personnel of the new associated companies, who will each assign one or more men on a full-time basis to work on the study.

The eleven companies are: Cincinnati Gas and Electric Company, Cleveland Electric Illuminating Company, Consolidated Edison Company of New York, Consumers Power Company, General Public Utilities Corporation, New England Electric System, Philadelphia Electric Company, Public Service Electric and Gas Company of New Jersey, Toledo Edison Company, Vitro Corporation of America, Wisconsin Electric Power Company.

In a recent speech at Salt Lake City, David Lilienthal, former chairman of AEC, said that the development of civilian nuclear power is being held up by the provisions of the McMahon Act.

AEC Appointments and Resignations.—T. KEITH GLENNAN, who left the presidency of Case Institute at Cleveland in August 1950 to become a member of the Atomic Energy Commission, has resigned as of November 1. Dr. Glennan wrote President Truman that commitments at Case Institute made it necessary for him to return "without further delay."

On November 15 EVERETT L. HOLLIS resigned as general counsel of the AEC. Mr. Hollis became a member of the Commission's staff in January 1947. From 1949 to 1951 he served as deputy general counsel; he has been general counsel since March 1951. Mr. Hollis will join the general counsel's staff of the General Electric Company in New York.

Mr. DON S. BURROWS has succeeded LINDSLEY H. NOBLE as controller of the AEC. Mr. Burrows was formerly controller of the Reconstruction Finance Corporation.

AEC Builds Cryogenics Laboratory.—The *Denver Post* on October 15 reported that the National Bureau of Standards "confirms reports that new cryogenics laboratory in Boulder, Colorado, operated under contract with AEC, is working with hydrogen." Authoritative sources are quoted as saying that experiments would *involve production of liquid hydrogen.*

Manpower

Proposed Scientific Manpower Commission.—Representatives of the American Chemical Society, the American Geological Institute, the American Institute of Biological Sciences, the American Institute of Physics, the Federation of American Societies for Experimental Biology,

and the American Association for the Advancement of Science have held several meetings to formulate proposals for a Scientific Manpower Commission. This new commission will be similar to the Engineering Manpower Commission and is planned to work in harmony with it. The representatives of the six groups which have been conferring agree that representation on the Scientific Manpower Commission should be on the basis of fields or disciplines rather than of individual organizations or societies. For this reason, the American Chemical Society, the Institutes, the Federation, and the AAAS have been chosen. It is felt that the American Psychological Association should be invited to participate and that the mathematical and astronomical societies should also be consulted to determine whether separate representation of these two disciplines is advisable.

The group urges that non-voting representatives of the several governmental agencies concerned be invited to take part in the policy-making meetings of the Scientific Manpower Commission. Among these agencies are the National Research Council, the NSRB, the National Science Foundation, the Department of Defense, the Department of Labor, and possibly the Office of Education.

Mr. Howard Meyerhoff, chairman of the committee outlining the tentative proposals for the commission, published in the October issue of *AIBS Bulletin*, says: "There is reason to urge the early establishment of the commission because the scientific manpower situation is acute, many aspects of it are receiving little if any attention, and all the time available is needed to develop a program that will be effective when and if new legislative and other emergencies arise. It is hoped that the commission can be made a reality before the close of the current year."

Citizens Advisory Commission on Manpower Utilization.—The Department of Defense has created a Citizens Advisory Commission on Manpower Utilization, headed by Brigadier General David Sarnoff, chairman of the board of the Radio Corporation of America. The primary task of this commission is to ensure that scientists, engineers, and technicians who are drafted are being used efficiently by the armed forces.

Office of Defense Mobilization Statement on Policy.—A comprehensive statement describing the duties of industrial employers, professional associations, universities, and government agencies in alleviating the shortage in scientific and engineering manpower has been issued by the Office of Defense Mobilization.[1] It is pointed out in the statement that there is a rising demand for scientific and technical manpower, with a supply declining until 1954. Only about 1 per cent of the 60 million civilians employed in the U.S. are engaged in biological and physical sciences and engineering. A large part of the national security and the continuance of high living standards depends on this small percentage of our population. The best possible use of this small supply of manpower is essential; and able young men and women must be recruited and properly trained in these fields.

[1] "Policy on Training and Utilization of Scientific and Engineering Manpower," *Federal Register*, XVII (Sept. 6, 1952), 8070–73.

Posthumous Award to Senator McMahon

The first Peace Award to be granted by the Catholic Association for International Peace was given posthumously to Senator McMahon for his work in bringing atomic energy under civilian control and his efforts toward "a positive program for waging peace which would eventually make arms unnecessary." In presenting the award to McMahon's daughter, the Rev. Raymond A. McGowan, executive secretary of the Association said that McMahon's struggle "symbolized the great paradox of the peace efforts of free men today." While McMahon "recognized the necessity of developing atomic weapons to ward off the threat of enslavement, he saw that arms alone could never bring real peace."

The Rosenberg Case

On November 21, four days after the Supreme Court refused for the second time to review the Rosenberg case, Federal Judge Irving Kaufman set the week of January 12 as the execution date for Ethel and Julius Rosenberg. Rosenberg and his wife were convicted in the spring of 1951 of passing atomic secrets to Soviet agents during time of war and were sentenced to die by Judge Kaufman.

Judge Kaufman has asked to be relieved of hearing the application to invalidate the conviction, which has been prepared by the Rosenberg attorney. On December 2, Judge Sylvester Ryan, who has taken Kaufman's place, reserved decision on the application for a new trial.

Point IV

Sixty-two representatives of underdeveloped countries concluded October 2, in Washington, D.C., a two-month study of ways to increase ownership of land by individuals and to improve agricultural production methods. This Point IV project was under the supervision of the Technical Cooperation Administration, Department of State, and the Mutual Security Agency, and included workshop discussion in Berkeley, California, and intensive conferences in Washington with Stanley Andrews, Point IV administrator; John Kenney, MSA deputy director; Charles F. Brannan, Department of Agriculture secretary; R. M. Evans, governor of the Federal Reserve Board, and others.

One of the chief aims of the project was to emphasize the place of credit as a means of increasing farm production and income, to determine the present facilities for credit in the countries concerned, and to find desirable measures to improve rural credit services in the countries.

Among the countries represented were Afghanistan, Bolivia, Colombia, Ecuador, Honduras, India, Iran, Israel, Libya, Pakistan, Paraguay, Peru, Thailand, Burma, Cambodia, Costa Rica, Cuba, Egypt, El Salvador, Indonesia, Iraq, Jordan, Laos, Lebanon, Mexico, Panama, Philippines, Syria, Uruguay, and Viet Nam.

A report was made by Secretary of State Dean Acheson September 8 that the Point IV program is now in operation in thirty-five countries of Asia, Africa, and Latin America, that it employs 1,200 "shirt-sleeve diplomats" working in association with 13,000 foreign technicians on projects aimed at wiping out hunger, poverty, and disease.

California Loyalty Oath

The California Supreme Court has ruled that a special oath or declaration cannot be required of college professors, thus putting an end to the controversy at the University of California over the special non-Communist oath imposed on the faculty.

National Science Foundation

New Appointments.—The Foundation has announced four new appointments to its staff. Dr. Fernandus Payne, zoologist from the Indiana University, will replace Dr. John Field as assistant director for the Division of Biological and Medical Sciences.

Dr. Louis Levin, head of biochemistry of the Office of Naval Research, has been named program director for regulatory biology. Dr. Frank H. Johnson, of Princeton University, will serve as program director for developmental biology, and Dr. William L. Duren, Jr., professor of mathematics at Tulane University, will be acting program director for mathematics.

Grants for 1953.—The National Science Foundation has announced its first group of awards from the 1953 fiscal year budget. A total of $728,250 has been given in 52 grants and two contracts. The research grants, averaging $6,300 per year, were made in the fields of astronomy, chemistry, developmental biology, earth sciences, engineering, genetic biology, mathematics, microbiology, molecular biology, physics regulatory biology, systematic biology, research education in science, scientific information, and special studies in science.

Six thousand dollars was given to pay the expenses of two scientific conferences; one on the topic, "Abundance of the Elements," was held in November at Yerkes Observatory, the other, the Third Annual Conference on High Energy Physics will be held at the University of Rochester, December 18–20.

A one-year grant of $10,000 was given to Science Service, Inc., for support of the Science Clubs of America; $3,600 was provided for the compilation and publication of a twenty-year cumulative index of the *American Journal of Physics;* and a 14-month grant of $65,000 was awarded the National Academy of Sciences for an evaluation of NSF fellowship applications for the academic year 1953–54, and an analysis of the fellowship programs.

Analysis of Federal Research Programs.—As a part of its statutory obligation to coordinate federal research programs, the National Science Foundation has made a preliminary analysis of the reports from eighteen government agencies which make government funds available for scientific research at nonprofit institutions. These data are summarized in Table 1 and Table 2.

Fellowship Program.—In October the second graduate fellowship program of the National Science Foundation began with the issuing of application forms to candidates. Fellowships granted will be for study during the academic year 1953–54 in the various scientific branches. A few postdoctoral fellowships will be granted, but emphasis is mainly on Master's and Doctor's degree work.

Applications, obtainable on written request to the Foundation, are due by January 5, and special examinations will be given throughout the United States on January 31.

Nearly six hundred students have received fellowships from the Foundation for the current year.

TABLE 1

PRELIMINARY ESTIMATES OF FEDERAL FUNDS FOR SCIENTIFIC RESEARCH AND DEVELOPMENT AT NONPROFIT INSTITUTIONS, BY SCIENTIFIC FIELDS, FOR YEARS ENDING JUNE 30, 1951 AND 1952

(Millions of Dollars)

Character of Work	Field of Work: Biological, Medical, and Agricultural Sciences		Physical, Mathematical, and Engineering Sciences		Social Sciences		Total	
	1951	1952	1951	1952	1951	1952	1951	1952
Basic research	14.1	15.7	59.8	54.0	1.9	1.4	75.8	71.1
Applied research	43.7	47.0	91.5	110.7	8.5	15.0	143.7	172.7
Development	2.8	3.1	51.4	74.0	0.3	0.2	54.5	77.3
Increase of research & development plant	5.6	4.0	17.1	16.2	0.2	–0–	22.9	20.2
Total	66.2	69.8	219.8	254.9	10.9	16.0	296.9	341.3

Source: National Science Foundation
November 13, 1952

TABLE 2

PRELIMINARY ESTIMATES OF FEDERAL FUNDS FOR SCIENTIFIC RESEARCH AND DEVELOPMENT AT NONPROFIT INSTITUTIONS BY SELECTED FEDERAL AGENCIES AND CHARACTER OF THE OBLIGATION, FOR YEARS ENDING JUNE 30, 1951 AND 1952

(Millions of Dollars)

Agency	Character of Work: Basic Research		Applied Research		Development		Increase of Research and Development Plant		Total	
	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952
Department of Defense	43.9	34.3	94.5	119.5	20.4	27.3	2.8	–0–	161.6	181.1
Atomic Energy Commission	24.4	27.9	22.7	26.6	30.5	46.4	20.1	20.2	97.7	121.1
Federal Security Agency (PHS)	5.1	5.1	11.7	12.8	0.2	0.4	–0–	–0–	17.0	18.3
Department of Agriculture	1.0	1.3	11.7	11.7	0.3	0.3	–0–	–0–	13.0	13.3
Other agencies	1.4	2.5	3.1	2.1	3.1	2.9	–0–	–0–	7.6	7.5
Total	75.8	71.1	143.7	172.7	54.5	77.3	22.9	20.2	296.9	341.3

Source: National Science Foundation
November 13, 1952

News from Abroad

European Council for Nuclear Research.—Representatives of the ten European nations which are planning a jointly financed nuclear research center held another meeting in Amsterdam this October. Plans were presented for building a "super-synchroton" based on recent discoveries made at Brookhaven National Laboratory. Professor Odd Dahl, of Norway, who visited Brookhaven in August to discuss a design for a 10,000,000,000 electron-volt synchroton, was vastly impressed by the new principle for focusing a strong magnetic field and returned with an alternative proposal for a 30,000,000,000 electron-volt "strong focusing synchroton." Professor Dahl estimated that the machine would take five or six years to build at a cost of $5,000,000. A cyclotron will also be built at the center, at an estimated cost of $4,000,000, and a building time of four years.

India.—A second plant for the production of uranium and thorium compounds is to be built in Travancore-Cochin state. It will utilize residues of Indian Rare Earths Ltd. and ores located by the Indian AEC. The Indian company will be associated with the Societe des Produits Chimiques des Terres Rares of Paris.

French Second Atomic Pile.—The second French nuclear reactor began operation at Saclay in early November. Like the first reactor, this will be used for nonmilitary atomic research.

Industrial Participation in British Atomic Development.—The British government is exploring the possibilities of asking industry to take a part in atomic energy research," according to Mr. G. Abrahamson, foreign correspondent of the *Chemical and Engineering News.* At a meeting of the Select Committee on Estimates, Lt. General Sir Frederick Morgan, controller of atomic energy, and Sir John Cockcroft, chief of the Harwell research establishment, said that while industry has not participated to date, the field is

about to be opened and methods considered whereby an opportunity for profit might be found and the energies of industry attracted to the project.

The British Information Service has announced that an experimental unit of an atomic power station will soon be built. Considerable research has been done. Recently a diagram, prepared by scientists at Harwell, illustrating how electricity might be produced in an atom-powered generating station was displayed at the Preston Guild Industrial Exhibition. Consumption of coal by British power stations is increasing so rapidly that 13,000,000 more tons may be required annually by 1960. The high cost of British mining and the fact that coal is one of Britain's chief exports intensify this country's interest in nuclear power.

Canada.—Sir John Cockcroft, head of the British Research Establishment at Harwell, claimed in a speech in Ottawa that Canada's pile at Chalk River is a research instrument that is "far and away the best in the world and likely to be so for several years to come." He said it had made possible a whole range of investigations in atomic energy and nuclear physics not possible elsewhere.

New Soviet Purge of the Sciences.—The head of the Soviet Union's Academy of Sciences, writing in *Izvestia*, has declared that large-scale "discussions" in the fields of biology, chemistry, geology, geography, physics and other sciences must be undertaken to destroy "obsolete and reactionary theories which hinder the forward movement of science." Mr. Topchiev cited the purge of genetics as a model case.

Argentina.—The Argentinian atomic energy project has come to naught, and there are rumors that its chief, the Austrian-born physicist, Dr. Ronald Richter has been placed under arrest. Although the Peron government has denied that Dr. Richter is in jail, the *New York Times* reports that villagers who live near the project say that the works have been closed and the workers dismissed.

In 1951 Peron announced that successful "thermonuclear experiments" had been achieved under Dr. Richter's direction, and that Argentina would have atomic power plants within eighteen months. Richter's claims were skeptically dismissed by U.S. physicists, who believed that his experiments were along lines that had been tried and found fruitless more than twenty years ago.

Nobel Prizes for 1952

The Nobel Prize in physics was awarded this year to two American scientists for their development of a new method of measuring magnetic fields in atomic nuclei. This technique, which is known as the nuclear magnetic induction method, was developed independently by the two physicists, Swiss-born Dr. Felix Bloch, of Stanford University, and Dr. Edward Mills Purcell, of Harvard University. This method enables scientists to increase a thousand-fold the precision of measurements of fundamental importance to the study of the structure of atomic nuclei.

The Nobel Prize in chemistry was shared by Dr. Archer Martin, of London, and Dr. Richard Synge, of Aberdeen, Scotland, for their development of paper partition chromatography. Dr. Selman A. Waksman, Russian-born American scientist of Rutgers University, New Brunswick, N.J., has been awarded the Nobel Prize in medicine for his work in the discovery of streptomycin and its effects against tuberculosis.

One of the Nobel prizewinners, Dr. Synge, was prevented from coming to the United States by the Department of Justice in the summer of 1949. Seventy-nine leading scientists attending the conference on proteins in which Dr. Synge wished to participate, protested his exclusion in a letter to President Truman. It was presumed that Dr. Synge was refused a visa because he attended the Cultural Congress for Peace at Warsaw in August 1948. Dr. Synge has said that he is not a member of the Communist party and is not politically active.

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The Origins of the Popularization of Science, by A. Laming, *Prehistorian*

The Parliamentary and Scientific Committee of Great Britain, by M. Philips Price, M.P.

Letter to the Editor

DEAR SIR:

The November issue of the *Bulletin of the Atomic Scientists* contained a substantially abbreviated edition of a speech that I gave last March. While I would agree that most of the material which you omitted was no longer of current interest, I feel that it was unfortunate to omit several sentences commending the men presently in charge of major projects and laboratories and urging that the Commission should give them fuller authority to proceed within the broad boundaries of budget and general objectives.

A substantially complete text of this speech can be found in *Nucleonics* for last April.

Yours very sincerely,

KENNETH S. PITZER

Dean, College of Chemistry
University of California

Civil Defense News

EUGENE J. SLEEVI

CD Appropriations for 1953 Fiscal Period

Congress voted $43 million for national civil defense preparations during the 1953 fiscal period. The Federal Civil Defense Administration asked for $600 million, almost twelve times the amount. Administrator Millard Caldwell said that Congress "has again ignored . . . repeated warnings" by voting what he called a "pittance."

He maintained that Congress has taken a "strange approach to the common defense program needed for this atomic air age" by voting $46 billion for military defense and only $43 million for the national civil defense program.

Of this amount, $15 million have been allocated in federal matching funds to states and territories on a dollar-for-dollar basis, making a total of $30 million for purchase of medical supplies and equipment, attack warning and other communications, fire-fighting and rescue equipment, and training and public education. The appropriation is being allotted to states and territories in the ratio which the total population of each bears to the total national population.

States and territories matched about $22,327,000 in federal contributions during 1952.

CDRA Survey

Four questions were asked of state and local civil defense directors in a nationwide survey conducted by the Civil Defense Research Associates, Inc., a nonprofit membership association serving as a "National Forum and Clearing House for Civilian and Industrial Protection."

These were: What effect, if any, will the cut in FCDA appropriations have on your operations and programs? What is your personal reaction? What reactions, if any, have you had from the "man in the street;" from your volunteer leadership? Realizing that regardless of the outcome of the election, there will be new leadership in the White House, with many administrative changes, what do you feel is most needed at the federal level?

About the answers, CRDA reports: "All through these replies is an expression of deep concern over the present CD status and the effect the congressional attitude is having on CD programs all over the country. In almost every instance there is mention of lack of leadership at the top level, and severe criticism of the conflicting statements being given out, creating confusion, doubt and discouragement in leaders of CD organizations and giving an 'out' to the 'man in the street' on whom the local CD directors must depend for an effective program."

A detailed report is available for one dollar from CDRA, 475 Fifth Avenue, New York 17, N.Y.

Dictionary of Civil Defense is a new publication issued by Philosophical Library, Inc., 15 East 40th Street, New York 16, N.Y. It outlines present-day civil defense in Great Britain. Items are arranged in alphabetical order, for quick reference. Contents include: civil defense organization, types and effects of high explosive (H.E.) bombs, unexploded bombs, standards of protection, types of shelters, protection for windows, sandbagging, principles of combustion and extinction; incendiary agents, fire fighting, stirrup pump, atomic bomb and its effects, war gases, gas attacks, detection of gases, elementary first aid, etc. The book is illustrated and its price is $3.75.

The Defense Department, FCDA, and Federal Communications Commisson continue their work on Conelrad (Control of Electromagnetic Radiation), the plan whereby commercial radio and TV stations can remain on the air during an air raid without giving enemy air navigators a radio broadcast beam which can be followed to target areas. Meanwhile, there will be a broadcasting and telecasting blackout in event of an air raid alert. However, rules and regulations concerning the new system will be issued by FCC soon. It should be ready for testing by the end of the year.

FCDA Training Schools Close

FCDA Deputy Administrator James J. Wadsworth reported that two of three training schools for state and city civil defense instructors have been closed because of the reduced congressional appropriation. They are the Central Training School at Oklahoma A & M College, Stillwater, Oklahoma, and the Eastern Training School at Pennsylvania State College's Extension School, Ogontz, Pennsylvania. The central school trained about 700 instructors during its year of operation, while the eastern school trained 275 instructors since it opened in February of this year. State, county, and city civil defense trainees now must obtain federal technical training at the FCDA Staff College, Olney, Maryland, or at the Western Training School at St. Mary's College, Berkeley, California.

Dispersion of Industry

Trends in Industrial Location, a report published by the National Industrial Conference Board, 247 Park Avenue, New York City, outlines postwar patterns in plant location and expansion. Usual expansion factors included proximity of existing facility, markets, raw materials, labor supply, transportation, water, fuel or power. However, national security and the tax rate structure are new location factors that are being given more consideration. The study, prepared by Malcolm C. Neuhoff, lists executive comments on centralization and decentralization of plant facilities. About 70 per cent of companies providing information on plant-location policies indicated that some decentralization of manufacturing activities is being practiced. Distribution of the report is limited to members and associates, but "exception is made in the case of schools, colleges and government agencies."

Women and Civil Defense

At least 60 per cent of civil defense volunteers must be women serving in hundreds of specialized civil defense jobs, FCDA maintains in a new publication entitled *Women in Civil Defense* (Government Printing Office, 15 cents). Since the home is the basic unit of the community, it must also be the basic unit on which defense of the home front is built, the booklet asserts. It outlines the steps every woman should take in family and community defense efforts.

A Summing Up

What's the current status of the national civil defense program? Federal Civil Defense Administrator Millard Caldwell recently listed some of the highlights:

1. More than three million American people have enrolled in civil defense. Training is under way.

2. Every state, territory, and hundreds of cities have designated civil defense directors and are developing operating civil defense organizations. All states but one and all territories have civil defense legislation. One exception is operating under an executive order.

3. "Eighty-seven per cent of the people in our major cities know a few of the simple things that must be done to protect themselves under atomic attack." This knowledge is the result of information provided by newspapers, radio, television, magazines, advertising, etc. Fifty million copies of nine official civil defense public education booklets and leaflets have been distributed, primarily at local or private expense.

4. Over 2,600,000 copies of twenty-five administrative guides and manuals have

been prepared and distributed by FCDA for technical guidance of state and local civil defense organizations.

5. Basic standard and job specifications for personnel and materials needed in civil defense have been set up. Manpower and equipment requirements for basic phases of civil defense operations have been determined.

6. The attack warning system is capable of sending an air-raid alert from USAF air defense control centers to 174 key point stations throughout the country in less than two minutes.

7. States and cities have appropriated $183 million for civil defense, $74 million more than the federal appropriation to date.

Caldwell concluded, "We have moved ahead toward a state of readiness at federal, state, and local levels. But much remains to be done before we have real civil defense preparedness."

Radiological Monitoring

FCDA Advisory Bulletin No. 127 lists revised recommendations for civil defense radiological monitoring instruments and tentative specifications for a medium range radiation survey meter. FCDA recommends use of three operational instruments:

1. A low intensity beta-gamma instrument for such operations as food, water and personnel monitoring; and for long-range survey work.
2. A medium range gamma survey meter for "rank and file" radiological monitors. This meter will be used for major portion of area survey and service monitoring immediately after an attack.
3. A high intensity beta-gamma survey meter to be used by specially trained monitors for survey in highly contaminated areas that must be occupied during emergency, and for making high level beta radiation measurements.

Blast-Proof Structure Designed

Windowless Structures—A Study in Blast-Resistant Design is the title of a recent FCDA publication of particular interest to architects and engineers who wish to design buildings which will afford protection from atomic blasts. Its number is TM-5-4, and it may be purchased from the Government Printing Office for one dollar.

In a Foreword, the editors insist that the manual should be regarded "merely as an introduction to this new field of structural design." A windowless, box-like structure entirely of reinforced concrete, is envisioned. It would offer protection against anything but a direct hit. FCDA authorities suggest that the structure could form a core for new buildings constructed in target areas.

Computations are included for designing a structure to take blast from bombs up to 1,000 times as powerful as the Hiroshima-type atomic bomb.

Plant Protection

The Department of Defense, in cooperation with the Office of Industrial Security and Munitions Board, has issued a supplement to its *Principles of Plant Protection* manual of August 1950. The new publication is called *Standards for Plant Protection* and is concerned with the physical protection of industrial facilities, especially those vital to mobilization for defense. Sections are included on the prevention of unauthorized entry, control of authorized entry, espionage and sabotage, minimization of damage, passive defense, fire defense, and restoration of production.

Second NYC Test Planned

Herbert R. O'Brien, new civil defense director of New York City, is formulating plans for the second city-wide public participation atom bomb test. It is scheduled for Saturday, December 13. During the drill, the public will be instructed to take cover in shelters. The first public participation exercise was held in November, 1951.

Items

A new civil defense law has been drawn up by the West German government for submission to the Bundestag, according to Drew Middleton in the *New York Times*. The government is conscious of the law's psychological effect on the people and has hesitated to bring the matter into the open. The Germans were the most heavily bombed people during World War II, Middletown writes, and the reactivation of a civil defense shelter program (scheduled for next spring) resembles "a return to a nightmare."

★ ★ ★

FCDA Advisory Bulletin No. 119 transmits United States Civil Defense Corps and Insigne Regulations together with a form of a certificate to be used by states in certifying their civil defense organizations for membership in the Corps. Legislation now pending before Congress makes membership in the Corps the basis for contributions to states for compensation for injury or death to a civil defense worker.

★ ★ ★

Two mobile disaster control centers are being organized by Milwaukee civil defense officials. They would go into operation if the city's regular control center is bombed out. Plans call for a portable center on the south and north sides of the city. One mobile center has had a test exercise. Police radio, amateur radio, communications, commissary, and supply units are included. If disaster throws the regular center out, one of the mobile units will be appointed the primary center.

Ten Years After

(*Continued from page 295*)

of an easy internationalism, which expressed itself in the many resolutions for world government passed by numerous state legislatures immediately after the war, has been dissipated; but a widespread progress in thinking on international matters, and a growing realization of American responsibility for the rational reorganization of the world, have remained. An understanding of the decisive role of science and technology in national and international developments, and of the possibility of utilizing the methods of science in public policy, is slowly emerging, even if it is continuously threatened by the wave of anti-scientific prejudice, released by the fear of atomic war, and the loss of American atomic secrets. The advances are small and far from secure. If the scientists, in general, and the *Bulletin* editors in particular, can contribute toward protecting and enlarging them, they have, perhaps, no right to retire in resignation and despair to their laboratories.

★ ★ ★

The problem has long since ceased to be entirely one of the use of atomic energy and, as such, of interest only to "atomic scientists." It has become one of the role of science and technology as a whole in national and international affairs, and is of equal concern to all physicists, chemists, biologists, and agricultural, engineering, and social scientists. For several years now, the *Bulletin of the Atomic Scientists* has carried the subtitle "Magazine for Science and Public Affairs." We are considering whether it might not be advisable to make this the main title of the magazine, keeping the subtitle "Bulletin of the Atomic Scientists," in recognition of the historic fact that it was the explosion of the first atomic bomb that has led to a decisive change in the political consciousness of scientists, and that the physicists and chemists emerging from the Manhattan Project, were the first to carry this spirit of social and political responsibility into public life.

—E. R.

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